Some comments regarding the future of nuclear power in the U.S.

Robert Rosner

William E. Rather Distinguished Service Professor

Depts. of Astrophysics and Physics, and Harris School of Public Policy

The University of Chicago

Nuclear Power is a hedge against the possible failure of effective grid storage …

- Decarbonizing the energy and transport sectors in response to climate change will require a transition to electricity production using renewables and other non-fossil fuel energy sources …
  - Non-fossil fuel, non-renewable, energy sources include nuclear fission power and (eventually) nuclear fusion power
- Renewables such as wind and solar power are inherently intermittent, and if used as the primary source of grid-scale power will require a significant grid-scale electricity storage capacity …
  - Such a capability does not exist today – it's a research problem – and there is no way of knowing when this capability will be available …
  - For this reason, utilities that are – by custom, law, and popular understanding – highly risk-averse will need to depend on a base power capability that is known to work today, and is not carbon-intensive: **The only such technology is nuclear power.**

Economics matters …

- The challenge for nuclear power – whether existing or new – is dealing with the low spot prices of power generated by natural gas combined cycle plants and subsidized wind and solar power.
  - This will continue to be true for the foreseeable future as long as the externalities of using fossil fuels is not priced (via a carbon tax or other mechanisms …)
  - Energy producers cannot be faulted for taking this economic reality into account … we live in a time in which quarterly results matter …
- This economic disadvantage of nuclear power is unrelated to the kinds of cost overruns for new nuclear power plant construction we've seen in the U.S. (Georgia and S. Carolina), Finland, and France …
  - Those cost overruns make the problem worse, but even if these projects were on time and budget, the economic disadvantage would remain as long as fossil fueled power receives an effective subsidy by not pricing its externalities …

Small modular reactors (SMRs) might help …

- The methods of constructing SMRs offer the *opportunity* for dramatic changes in the capital construction costs of nuclear power …
  - The idea is to replicate the construction methods developed by – for example – the air frame industry (e.g., Boeing and Airbus), which rely on a factory-built, assembly line-style methodology to move from the expensive "First-of-a-kind" (FOAK) costs of early prototypes to market-competitive "Nth-of-a-kind" (NOAK) construction costs
  - This approach however relies on the existence of an 'order book', i.e., a list of of customers that have committed to buy – this is how the aircraft industry amortizes the 'learning curve' necessary to achieve NOAK costs, namely over the ensemble of airplanes that have been pre-sold.
  - Right now, the U.S. Dept. of Energy is supporting one SMR vendor (NuScale), and anticipates building a prototype at Idaho National Lab – but there is as yet no order book … and without that, the economics look bleak for SMRs in the U.S. …

Germany's experience should be a warning …

- The Germans (a) are committed to decarbonizing their economy, reaching at least 80% renewable by 2050, and (b) have also decided to exit nuclear power by 2022 …
  - In the absence of new nuclear builds, we will be in the same position: Our existing nuclear fleet will go out of service by the 2040s – the only surviving plants by 2050 will be those plants currently under construction …
  - The German experience to date is that maintaining secure electricity service while eliminating nuclear power requires increased reliance on coal-powered power plants – this is true even though Germany has power purchase agreements with (for example) the French.
  - The considerable subsidies paid to German producers of wind and solar power have also meant that Germain electricity costs are very high: ~ €0.30/kWh compared to Illinois costs of ~$0.0789/kWh (30-month contract)
  - This price shock may well be in our future unless natural gas prices stay at current levels until (and past) mid-century … who's willing to bet on that?

… and then there's the matter of the spread of nuclear power world-wide

- It is well-recognized that the key concern about the ongoing spread of nuclear power in the developing world relates to proliferation of nuclear expertise, and the increased threat of nuclear weapons proliferation …
  - The U.S. played a decisive role in non-proliferation issues world-wide until the 1990s …
  - With the demise of our nuclear plant suppliers – Westinghouse and GE have not built a nuclear powerplant in decades – we have demonstrably lost influence …
    - Example: During the Bush Administration, the U.S. attempted to have a number of nations sign so-called 'gold-standard' 123 (bilateral) Agreements (extending the 'standard' 123 agreement to include commitments not to enrich and not to reprocess), but even allies such as Australia refused to sign …
  - With the demise of the nuclear industry in the U.S. – assuming no further 'new builds' – our international influence (and <u>perceived</u> expertise) is likely to continue declining … is this what we want?

Summary …

- Nuclear power is an effective hedge against future technological limits on grid-scale storage of electricity
- Economics matters – and nuclear power is at a significant disadvantage as long as it competes on spot markets with natural gas-powered power and renewables, both of which currently receive large effective subsidies
- SMRs may help on the economic front – but in the absence of an ‘order book’ for such plants, they are not likely to be economically viable …
- If we value the U.S. role in maintaining nuclear non-proliferation, the decline of our nuclear industry should cause considerable alarm …